CHAPTER 9

RESIDUALS DISPOSAL

9.1 Introduction

Proper maintenance of onsite treatment systems requires periodic disposal of residual solids, sludges, or brines. In some areas, finding environmentally sound techniques for disposal of these residuals has been very difficult. Because of the possible presence of pathogens in many of these wastewaters, proper handling and disposal are important from a public health perspective. The homeowner's role in residuals handling is to ensure that residuals from his system are removed periodically at the appropriate interval so that proper system performance is maintained.

This chapter discusses the characteristics of residuals, and describes treatment and disposal options for septage (septic tank pumpings). The chapter is intended to be merely an overview of residuals handling options. The reader is referred to publications that discuss particular alternatives in greater detail.

9.2 Residuals Characteristics

Table 9-1 summarizes the residuals that may be generated by onsite wastewater handling systems. Typical characteristics, removal frequencies, and disposal modes are presented. Many of the residuals listed may contain significant amounts of pathogenic organisms, nutrients, and oxygen-demanding materials; thus, they require proper handling and disposal to protect public health and to prevent degradation of groundwater and surface water quality.

In general, residuals generated by onsite wastewater systems are highly variable in character. This is due to several factors, including type and number of fixtures, number and age of occupants, type of wastewater treatment system, and user habits.

The wastewater removed from septic tanks, commonly referred to as septage, is the most common residual generated from onsite wastewater systems. The characteristics of septage are presented in Tables 9-2 and 9-3. While information on septage characteristics and treatment/disposal alternatives is relatively abundant, data on other residuals listed in Table 9-1 are limited.

TABLE 9-1

RESIDUALS GENERATED FROM ONSITE WASTEWATER SYSTEMS (1)

Residual	Source	Frequency of Removal	Characteristics	Disposal[a]
Septage	Septic tank	2 to 5 yr	High BOD and SS; odor, grease, grit, hair, pathogens	Pump out by professional hauler for off-site disposal.
Sludge	Aerobic unit	1 yr	High BOD and SS; grease, hair, grit, pathogens	Pump out by professional hauler for off-site disposal.
Sewage	Holding tank	week to months	Strong septic sewage; odor, pathogens	Pump out by professional hauler for off-site disposal.
Blackwater	Holding tank	6 months-1 yr	High BOD and SS; odor, pathogens	Pump out by professional hauler for off-site disposal.
Recycle Residuals	Recycle systems	6 months-1 yr	Variable depending on unit processes employed	Pump out by profesisonal hauler for off-site disposal.
Compost	Compost toilet; large small	 6 months-1 yr 3 months	Relatively stable, high organics, low pathogens	Homeowner performs onsite disposal; garden burial.
Ash	Incinerator toilet	weekly	Dry, sterile, low volume	Onsite burial by homeowner or disposal with rubbish to landfill
Scum	Sand filters	6 months	Odor, pathogens, low volume	Onsite burial by homeowner or off-site disposal

[a] Approval by state or local regulatory agency necessary.

TABLE 9-2

CHARACTERISTICS OF DOMESTIC SEPTAGE

Parameter	Mean Value mg/l	Reference
Total Solids	22,400	2
	11,600	3
	39,500	4
Total Volatile Solids	15,180	2
	8,170	3
	27,600	4
Suspended Solids	2,350	2
	9,500	3
	21,120	5
	13,060	6
Volatile Suspended Solids	1,770	2
	7,650	3
	12,600	5
	8,600	6
BOD	4,790	2
	5,890	3
	3,150	6
COD	26,160	2
	19,500	3
	60,580	4
	24,940	5
	16,268	6
pH	6-7 (typical)	2,3,4
Alkalinity ($CaCO_3$)	610	3
	1,897	5
TKN	410	3
	650	4
	820	5
	472	6
NH_3-N	59	2
	100	3
	120	4
	92	5
	153	6

TABLE 9-2 (continued)

Parameter	Mean Value mg/l	Reference
Total Phosphorus	190	3
	214	4
	172	5
	351	6
Grease	3,850	3
	9,560	4
Aluminum	48	6
Arsenic	0.16	6
Cadmium	0.1	3
	0.2	4
	9.1	6
Chromium	0.6	3
	1.1	6
Copper	8.7	3
	8.3	6
Iron	210	3
	160	4
	190	6
Mercury	0.02	4
	0.4	6
Manganese	5.4	4
	4.8	6
Nickel	0.4	3
	<1.0	4
	0.7	6
Lead	2.0	3
	8.4	6
Selenium	0.07	6
Zinc	9.7	3
	62	4
	30	6

TABLE 9-3

INDICATOR ORGANISM AND PATHOGEN CONCENTRATIONS IN DOMESTIC SEPTAGE

Parameter	Typical Range counts/100 ml	Reference
Total Coliform	10^7 - 10^9	5
Fecal Coliform	10^6 - 10^8	4,5,7
Fecal Streptococci	10^6 - 10^7	4,5,7
Ps. aeruginosa	10^1 - 10^3	4,5,7
Salmonella sp.	<1 - 10^2	4,5
Parasites		
Toxacara, Ascaris lumbricoides, Trichuris trichiura, Trichuris vulpis	Present	5

Septage, a mixture of sludge, fatty materials, and wastewater removed during the pumping of a septic tank, is a difficult and undesirable material to handle. It is often highly odoriferous and may contain significant quantities of grit, grease, and hair that may make pumping, screening, or settling difficult. Of particular importance is the high degree of variability of this material, some parameters differing by two or more orders of magnitude. This is reflected to some extent by the variability in mean values presented in Table 9-2. For this reason, septage should be characterized prior to selection of design values.

In general, the heavy metal content of septage is low relative to municipal wastewater sludge, although the range of values may be wide. Because of the low metal content, application rates may be based on nitrogen rather than metal loading for land application systems (8).

Table 9-3 presents typical concentration ranges for indicator organisms and pathogens in septage. These values are not unlike those found for raw primary wastewater sludge. It is evident that septage may harbor disease-causing organisms, thus demanding proper management to protect public health.

Accumulation rates of residuals differ for the same reasons that account for their variability in characteristics: that is, type and number of fixtures, occupancy characteristics, type of wastewater system, user habits, etc. The figures presented in Table 9-1 for frequency of residuals removal reflect typical ranges found in practice, although the range of actual values may be greater.

9.3 Residuals Handling Options

Residuals that potentially may be disposed of onsite by the homeowner include compost from compost toilets, ash from incinerating toilets, and the solids mat from sand filters. Assuming proper operation of the unit, ash from incinerating toilets is sterile and can be safely disposed by mixing it with soil on the homeowner's property, or by handling with household solid wastes. Residuals from compost toilets are relatively stable, but may contain pathogenic bacteria and virus, especially if the system has not been properly operated and maintained. Onsite burial is approved in some states but not in others, due to the possible health hazards of handling the waste. The same conditions hold for disposal of the scum that must be periodically raked off filtration units.

Pathogens may be present in the scum layer, and approval for onsite disposal varies with locale. The appropriate state or local regulatory agency should be consulted for the requirements in a particular area.

As Table 9-1 indicates, the residues from septic tanks, aerobic treatment units, holding tanks, and recirculating toilets must be periodically pumped out and disposed of by professional haulers. The homeowner's responsibility should be to ensure that this service is provided before residuals buildup impairs performance of the treatment unit.

9.4 Ultimate Disposal of Septage

By far the most common waste material generated from onsite systems is septage. The following discussion provides a brief overview of techniques for disposal of this waste. For a more complete description of these processes, the reader is referred to the list of references at the end of this chapter.

There are three basic methods for disposing of septage: disposal to 1and, treatment and disposal at separate septage handling facilities, and treatment at existing wastewater treatment plants.

9.4.1 Land Disposal

Four methods can be used for disposing of septage to land: surface spreading, subsurface disposal, trenching, and landfilling. Table 9-4 summarizes the main characteristics of these disposal techniques.

Land spreading is the most frequently used septage disposal method in the United States. Surface spreading of septage is generally accomplished by the same techniques as municipal liquid wastewater sludge spreading. This may simply involve the septage pumping truck emptying its contents on the field while slowly driving across the site. This technique has very low operation and maintenance requirements. A more controlled approach is to use a holding tank to receive septage loads when the soil is not suitable for spreading. A special vehicle (tractor or truck with flotation tires) can then be used to spread the septage when weather and soil conditions permit.

Subsurface disposal techniques have gained wide acceptance as alternatives for disposal of liquid sludge and, to some extent, septage. Three basic approaches to subsurface disposal are available:

1. Incorporation using a farm tractor and tank trailer with attached subsurface injection equipment.

2. Incorporation using a single, commercially available tank truck with subsurface injection equipment.

3. Incorporation using tractor-mounted subsurface injection equipment in conjunction with a central holding facility and flexible "umbilical cord." Liquid sludge is continually pumped from the holding tank to the injection equipment.

Disposal of septage by burial in excavated trenches is another common disposal technique. Trenches are typically 3 to 6 ft (0.9 to 1.8 m) deep and 2 to 3 ft (0.6 to 0.9 m) wide, with dimensions varying with site location. Space between trenches should be sufficient to allow movement of heavy equipment. A series of trenches is usually dug by a backhoe to allow sequential loading and maximum dewatering. Septage is usually applied in 6- to 8-in. (15 to 20 cm) layers. When the trenches are full, the solids can be excavated and placed in a landfill if they have dewatered sufficiently, or the trenches can be covered with 2 ft (0.6 m) of soil. A thorough site evaluation is essential to prevent groundwater contamination with this disposal technique.

TABLE 9-4

LAND DISPOSAL ALTERNATIVES FOR SEPTAGE

Alternative	Design Considerations	Advantages	Disadvantages
Subsurface Disposal (1)(2)(8)(9)(17)(19)	Septage volume/characteristics Climate Site characteristics - Soil type/permeability - Depth to groundwater or bedrock - Aquifer size, flow characteristics, use - Slope - Proximity to dwellings, etc. - Crop and crop use - Size of site - Site protection Equipment selection Application rate Winter storage or contingency plan Monitoring wells	Low human contact potential Low incidence of odors and vectors Aesthetically more acceptable than surface spreading Good soil amendment	Large land requirements Storage may be required during inclement weather - wet or frozen ground Need more equipment than for surface spreading
Surface Spreading (1)(2)(8)(9)(17)(19)	Septage volume/characteristics Application rate (N loading) Climate Storage facilities Site characteristics (same as subsurface disposal) Equipment selection Monitoring wells	Small labor requirement Minimum equipment required Benefit from fertilizer - Soil amendment value Low cost Simple Operation	Possible odor and aesthetic nuisance Spreading restricted by wet or frozen soil Storage may be required during inclement weather Pretreatment may be required for deodorization and pathogen destruction Possible human contact or vector attraction

TABLE 9-4 (continued)

Alternative	Design Considerations	Advantages	Disadvantages
Trench Disposal (1)(9)(17) (18)	Septage volume/characteristics Site characteristics - Soil type/permeability - Depth to groundwater or bedrock - Aquifer size, flow characteristics, use - Proximity to dwellings, etc. - Proximity to septage sources Site protection Equipment selection Design life Monitoring wells	Simple operation Low labor requirement Minimal equipment required Low cost Less land required than surface or subsurface spreading operations	Higher potential for groundwater contamination Odors and vectors Limited design life - usually cannot use same land repeatedly
Sanitary Landfill Disposal (1)(9)(14)	Septage/refuge ratio Leachate collection/treatment Monitoring wells	No new equipment needed Low odor and pathogen problems due to daily soil cover Low cost	Limited application due to leachate generation Good operating procedures required - refuse/septage mixing Extensive monitoring required - leachate, runoff, groundwater May not be approved in some states

Sanitary landfills in the United States generally accept a multiplicity of materials such as refuse, industrial wastes, and sometimes hazardous or toxic wastes. All of these wastes are compiled on a daily basis at the landfill and buried under a soil cover. The acceptance of septage at a landfill depends chiefly on the ratio of the mixture of septage to refuse to maintain moisture control. However, a few states do not allow landfill disposal of septage, and some others do not recommend it because of potential runoff and leachate problems.

9.4.2 Independent Septage Treatment Facilities

In some areas of the country, facilities have been constructed exclusively for handling septage. These systems vary from simple holding lagoons to sophisticated, mechanically based plants. The latter systems are generally more capital intensive, and may also have greater operational requirements. Such systems have been found to be cost effective in areas of significant septic system density, such as Long Island, New York. In rural areas, simpler, less expensive alternatives may be more economically favorable. Of the independent facilities listed in Table 9-5, lagoons are the most common and among the least expensive independent septage handling alternatives. All of the other independent systems have been implemented to some degree, although in most cases, not widely.

9.4.3 Septage Handling at Wastewater Treatment Plants

Two methods exist for handling septage at wastewater treatment facilities: addition to the liquid stream (near the headworks or upstream from the plant), or addition to the solids handling train (see Table 9-6). Both have advantages under appropriate conditions. For example, addition to the headworks (screens, grit chamber) is desirable where the plant employs primary clarification, since this effectively introduces the septage solids directly into the sludge handling scheme. For extended aeration plants, however, septage addition to the wastewater flow may have a severe impact on the aeration capacity of the system. Thus, introducing the septage into the sludge stream may be desirable. Consideration of plant aeration and solids handling capacity is necessary to determine whether either scheme is feasible. Under either mode of addition, solids production increases with increased septage addition. Septage holding facilities allow controlled addition of the septage to the wastewater treatment plant.

For additional information on the capability of wastewater treatment facilities to handle septic tank pumpings, the reader is referred to the publications list in Section 9.5 (3)(11).

TABLE 9-5

INDEPENDENT SEPTAGE TREATMENT FACILITIES

Process	Description	Design Considerations	Advantages	Disadvantages
Lagooning (1)(13)(14) (16)(17)	Usually anaerobic or facultative Inlet on bottom for odor control Liquid disposal by percolation and evaporation in lagoon or by separate infiltration bed pH adjustment to pH 6-8 may be necessary for odor control	Septage volume/characteristics Site location - Distance to dwellings, etc. - Depth to groundwater or bedrock - Distance to surface water Depth of liquid, surface area Climate Aquifer characteristics Monitoring wells Solids removal and disposal	Low cost Simple operation	Odor problems if pH not maintained Cannot use in areas with high water table Possible vector problem Soil clogging may stop percolation
Lime Stabilization (1)(4)(5)	Collection, mixing. and reaction with lime to pH 12 (hold 1 hour) Dewatering optional Odors eliminated, pathogens greatly reduced	Septaqe volume/characteristics Septage receiving/holding Mixing (air or mechanical) Lime handling and feeding Final disposal	Odor eliminated Good pathoqen reduction Low land requirement Enhanced solids dewatering	No reduction in orsanic matter Lime increases auantitv for final disposal High cost for labor and lime Unknown effects of long-term storage
Chlorine Oxidation (1)(9)(15)	Chlorine and septage mixed in pressurized reaction chamber pH 1.2 - 2.5 Chlorine dosage 700-3,000 mg/l	Septage volume/characteristics Equipment sizing Septage receiving/holding Dewatering facilities Final solids disposal Chlorine storage/safety	Stable, odor-free sludge produced High pathogen destruction Enhanced solids dewatering Low land requirement	Hioh operatina costs dependent on chlorine cost Neutralization may be rewired Question of harmful chlorinated organics Underdrainage liquor requires further treatment
Aerobic Digestion (1)(9)(13)	Similar to aerobic digestion of sewage sludge Often accomplished at existing wastewater treatment plant	Septage volume/characteristics Septage receiving/holding Organic loadina Solids retention time (20-30 days) Climate (temperature) Mixing and DO level Final disposal	SS reduction BOD reduction Reduction of Odor and pathogens May enhance solids dewatering Low land requirement	Biological operation not simple Subject to organic overloading Requires monitoring and lab analysis Can have foaming problems

TABLE 9-5 (continued)

Process	Description	Design Considerations	Advantages	Disadvantages
Composting (1)	May be natural draft or forced air Septage mixed with bulking material High temperature/pathogen destruction Storage/distribution	Septage volume/characteristics Septage receiving/holding Bulking agent availability Dewatering Materials handlinq capability	Provides pathogen destruction and stabilization Produces soil amendment Operationally simple Low energy requirements	High bulking agent requirement if not dewatered Product market must be established May be labor-intensive
Anaerobic Digestion (9)(11)	Often accomplished in combination with sewage sludge Demonstrated on pilot-scale Identical to sludge digestion technology	Septage volume/characteristics Septage receiving/holding Grit removal Solids retention time Maintenance of digester temperature No toxic materials input Final disposal	Methane recovery/ utilization possible Stabilized product Can handle variety of organic wastes	Biological process requires close operator control Subject to upset by toxics Requires continuous supply of organic materials
Chemical Treatment (1)(9)(10)	Chemical coagulation - Mixing and settling - Supernatant collection, treatment/disposal - Sludge holding/dewatering/disposal Acidification (H_2SO_4) - Mixing and settling - Additional coagulation possible with lime	Septage volume/characteristics Seotage receiving/holding Chemical feed equipment and dose levels Mixing, reaction time, settlinq time Final disposal	Low land reauirement	High labor requirement High costs
Dewatering (1)(10)	Drying beds Pressure filtration Vacuum filtration Drying lagoons Centrifugation	Septage volume/characteristics Septage receiving/holding SS concentrations Filterability Pretreatment-chemical conditioning Final disposal	Reduced hauling costs Reduces area required for disposal	High cost for some alternatives High operation and maintenance requirements Mechanical dewatering devices require an enclosure

TABLE 9-6

SEPTAGE TREATMENT AT WASTEWATER TREATMENT PLANTS

Process	Description	Design Considerations	Advantages	Disadvantages
Liquid Stream Addition (3)(6)(11)(12)	Septage placed in storaqe tank at plant Pretreatment (screening, grit removal) Controlled bleed into headworks to prevent shock overload	Septage volume/characteristics Plant caoacity (aeration and solids handling) Receiving station - Truck transfer - Storage - Pretreatment (optional) - Controlled discharqe to plant Sludge production O&M (power, labor, chemicals)	Easily implemented Low capital cost Public acceptance qood Particularly desirable at plants with primary clarification	Additional sludge generation May organically overload plant Increased O&M Final disposal site and sludge equipment expansion may be needed
Sludge Stream Addition (6)(11)(12)	Septaqe placed in storage tank Fed directly into sludge stream with or without separate conditioning/ handling	Septage volume/characteristics Septage receiving/holding Organic and solids loading on each sludqe handlinq unit Pumping and storage capacity Additional mixing and feeding equipment Increase in chemical usage	Avoids overloading secondary and tertiary systems Avoids possibility of final effluent degradation	Additional sludge generation Final disposal site and sludge equipment expansion may be needed

9.5 References

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